

SECTION 606 UNDERDRAINS

606.1-DESCRIPTION:

This work shall consist of constructing underdrains and free draining base trenches using pipe and granular material, blind drains, aggregate filled engineering fabric, prefabricated pavement edge drain and underdrain pipe outlets in accordance with these Specifications and in reasonably close conformity with the lines, grades, dimensions and locations shown on the Plans or established by the Engineer.

When Item 606025-*, UNDERDRAIN PIPE, per linear foot (meter), is included as a pay item in the Contract, any of the following pipe types may be furnished for construction of the underdrain: bituminous coated corrugated steel underdrain pipe, corrugated aluminum alloy underdrain pipe, non-reinforced perforated concrete underdrain pipe, porous concrete pipe, standard strength perforated clay pipe, extra strength perforated clay pipe perforated bituminous fiber underdrain pipe, corrugated stainless steel underdrain pipe, precoated, galvanized steel pipe for underdrains, corrugated polyethylene underdrainage pipe or perforated plastic semicircular pipe.

606.2-MATERIALS:

Material shall meet the requirements specified in the following Subsections of Division 700:

MATERIAL	SUBSECTION	TYPE OR GRADATION
Metallic Coated Corrugated Steel Pipe for underdrains	713.11	Class I, II or III
* Bituminous Coated Corrugated Steel Pipe for Underdrains	713.12	Class I, II or III
***Corrugated Aluminum Alloy Pipe for Underdrains	713.16	Type I, II, II or IV
***Bituminous Coated Corrugated Aluminum Alloy Pipe for Underdrains	713.17	Type I, II, II or IV
* Precoated Metallic Coated Steel Pipe for Underdrains	713.23	Class I or II, Type B Coating

MATERIAL	SUBSECTION	TYPE OR GRADATION
Corrugated Stainless Steel Pipe for Underdrains	713.7	
Non-Reinforced Perforated Concrete Underdrainage Pipe	714.5	Class I 2 or 3
Porous Concrete Pipe	714.6	Class I or II
Standard Quality Concrete Drain Tile	714.7	
Extra Quality Concrete Drain Tile	714.7	
Special Quality Concrete Drain Tile	714.7	
Standard Clay Drain Tile	714.8	
Extra Quality Clay Drain Tile	714.8	
Heavy Duty Clay Drain Tile	714.8	
Standard Strength Perforated Clay Pipe	714.10	
Extra Strength Perforated Clay Pipe	714.10	
Cradle Invert Clay Pipe	714.10	
**Bituminous Fiber Pipe: Non-Perforated	714.14	
Perforated	714.15	
*****Crushed Stone for Underdrains	703.1 & 703.4	AASHTO Size # 67, 7 or 78
*****Gravel for Underdrains	703.2 & 703.4	AASHTO Size # 67, 7 or 78
Silica Sand for Underdrains	702.1.2, 702.1.3 & 702.6	
Engineering Fabric	715.11	

MATERIAL	SUBSECTION	TYPE OR GRADATION
Concrete for Miscellaneous Uses	715.12	
Prefabricated Pavement Edge Drain	715.10.1	

* Unless otherwise specified, Class IV, semicircular pipe 4 5/8 inches (117 mm) in diameter, may be furnished when 6 inch (150 mm) diameter pipe is called for on the Plans.

** Unless otherwise specified. Perforated pipe shall be used.

*** Unless otherwise specified. Type V, semicircular pipe 4 5/8 inch (117 mm) in diameter, may be furnished when 6 inch diameter pipe is called for on the Plans.

**** Plastic semicircular pipe may be furnished only when six (150 mm) diameter is called for on the Plans.

***** Aggregate for aggregate filled fabric underdrain shall consist of crushed stone conforming to the requirements of 703.1 or gravel conforming to the requirements of 703.2. The grading may be any standard AASHTO size between # 2 and # 57, inclusive, but only one size may be used at any one installation. Pea gravel as described in 703.2.3 may also be used.

When the locations of manufacturing plants allow, the plants may be inspected periodically for compliance with specified manufacturing methods, and material samples may be obtained for laboratory testing for compliance with material quality requirements. This may be the basis for acceptance of manufacturing lots as to quality.

All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials in the work.

CONSTRUCTION METHODS

606.3-PIPE INSTALLATION:

606.3.1-Trenching: Trenches shall be excavated to a width of the outside diameter of the pipe plus 1 ft. (300 mm), to a depth of 4 inches (100 mm) below the flow line, and to the grade required by the Plans or as directed. Trench walls shall be as nearly vertical as practicable.

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606.3.2-Bedding and Placing Pipe: A minimum 4 inch (100 mm) bedding layer of crushed gravel shall be placed in the bottom of the trench for its full width and length.

Subdrainage pipe of the type and size specified shall be embedded firmly in the bedding material. Upgrade ends of all underdrainage pipe installations shall be closed with suitable plugs to prevent entry of soil materials.

Perforated pipe shall normally be placed with the perforations down. Flexible pipe sections shall be joined with couplings or bands as recommended by the manufacturer. Non-perforated pipe and rigid pipe shall be firmly set and laid with the bell and groove ends upgrade and with open joints, wrapped with suitable material when specified, to permit entry of water.

606.3.3-Placing Filter Material: After the pipe installations have been inspected and approved, crushed stone or crushed gravel shall be placed to a height of 6 inches (150 mm) above the top of pipe. The trench shall then be filled with silica sand to a minimum thickness of 12 inches (300 mm) over the top of the filter stone or gravel. In the event damp trench sides indicate the necessity; the Engineer may direct an increase in the thickness of the silica and cover. When the underdrain is used to drain the base or subbase, course, the sand filter shall be carried vertically to the bottom of the base or subbase. Care shall be taken not to displace the pipe or the covering at open joints.

When there is a heavy percolation of water into the trench at underdrain level, the Engineer may substitute sand for the crushed stone or gravel bedding, cover and filter.

606.3.4-Backfill: Above the sand filter, when underdrains are not used to drain the base or subbase, the trench shall be filled with suitable random material, as shown on the Plans or as directed by the Engineer, in layers not exceeding 4 inches (100 mm) after compaction. The use of bulldozers or other blade equipment in backfilling is expressly prohibited.

The quality control testing and acceptance of suitable soil, soft shale or granular material will be according to applicable sections of 207 and 716, with the following exceptions:

A lot normally consist of the quantity of backfill material required to backfill 100 linear ft. (30 m) of the installation, or as directed by the Engineer.

For underdrain installations in an embankment, where existing tests are on file for the adjacent embankment material, the target percentage of dry density for the suitable random backfill will be equal to the X value of the tests in the adjacent lot of embankment material or a minimum value of 95, whichever is greater. For embankments where no tests are on file, the target percentage of dry density will be 95.

606.3.5-Underdrain Outlets: Trenches for underdrain outlets shall be excavated as for underdrains, except that the depth of the trench shall be limited to the flow line. Pipe shall be laid in the trench with all ends firmly joined by the applicable methods and means. The use of perforated pipe may be omitted

or, if used, it shall be laid with perforations up. No filter material shall be used. After inspection and approval of the pipe installation, the trench shall be backfilled with suitable material in layers and compacted as provided for underdrains.

606.4-UNDERDRAIN STRUCTURES:

606.4.1-Underdrain Junction Boxes: Underdrain junction boxes shall be constructed to the dimensions and elevations at locations as shown on the Plans or as directed.

606.4.2-Slope Walls for Underdrains: Slope walls for underdrains shall be constructed of concrete conforming to the requirements of 715.12 of the Specifications and shall be constructed to the dimensions and elevations at locations as shown on the Plans or as directed.

606.5-SPRING CONTROL:

Underdrain spring boxes and underdrain for spring control shall be constructed to the dimensions and elevations at locations as shown on the Plans, or as directed. Any remaining upper portion of the trench shall be filled and compacted as for underdrains.

606.6-AGGREGATE FILLED FABRIC UNDERDRAIN AND BLIND DRAINS:

Trenches for aggregate filled fabric underdrains and blind drains shall be excavated to the width and depth shown on the plans. The trench shall be prepared to a relative smooth state, free of sharp protrusions, depressions, and debris.

When fabric is used, it shall be placed with the long dimension parallel to and centered with the alignment of the trench. It shall be placed in the trench in reasonable conformance with the shape of the trench and shall be smooth and free of tension, stress, folds, wrinkles or creases. The fabric shall be installed so that any splice joints have a minimum overlap of at least 2 feet (600 mm) in the direction of flow. The overlap of the closure at the top shall be approximately the width of the trench and shall be temporarily used to cover the excavated material on either side of the trench.

The aggregate shall be placed by any method which will result in the trench being completely filled to the line shown. The filling process shall not cause the permeability of fabric to be impeded.

The fabric, when used, shall be overlapped at the top of the aggregate. Any portion of the trench not filled with aggregate shall be backfilled in accordance with 606.3.4.

606.7 - PREFABRICATED PAVEMENT EDGE DRAIN:

Trenches for prefabricated pavement edge drain shall be excavated to the dimensions and grade shown on the Plans.

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The edge drain shall be placed against the pavement side of the trench and held firmly in place while backfill is placed to a compacted height of not more than 6 inches (150 mm). For one-sided drains, the more open side shall be placed toward the pavement. After the first lift is compacted and any tears in the fabric have been satisfactorily repaired, the remainder of the backfill shall be placed and compacted in layers not exceeding 6 inches (150 mm) deep. All compaction shall be accomplished with a vibratory compaction system. The backfill shall be the material excavated from the trench. Unless otherwise approved by the Engineer, the excavation of the trench, the placement of the edge drain, and the placement of the first lift of backfill shall be accomplished in a single continuous operation.

Each segment of edge drain shall be joined to the adjacent segment prior to installation. Splices shall keep the adjoining edge drain in proper alignment and shall not separate during installation.

Four inch (100 mm) diameter non-perforated outlet pipes shall be installed to provide positive drainage at low points of sags, at the low ends of all runs and at intervals not exceeding 500 ft. (150 m) on continuous runs, except edge drains with two separate flow channels shall have a crossover coupling at approximately 250 ft (75 m). The manufacturers' recommended fittings shall be provided for attaching the edge drains to the outlet pipes. A standard underdrain concrete slopewall shall be used at each pipe outlet unless the pipe is connected to a drainage structure. Slopewalls shall be fitted with a galvanized rodent screen.

The outlet pipe trench shall be constructed in accordance with 606.3.4 and 606.3.5 using as backfill the material excavated from the trench.

606.8- FREE DRAIN BASE TRENCH:

This work shall consist of constructing free draining base trenches and Outlet Pipes in accordance with these specifications and in reasonably close conformity with the lines, grades, dimensions, and locations shown on the plans or established by the Engineer.

606.8.1 - MATERIALS:

The perforated pipe as detailed on the plans shall meet the requirements of this Section.

The aggregate backfill as detailed on the plans shall meet the requirements of section 311.2 aggregate.

Engineering fabric shall meet the requirements of Subsection 715.11.8.

The Outlet pipe as detailed on the plans shall meet the requirements of Subsection 715.10.1.5.

CONSTRUCTION METHODS

606.8.2 - FDB TRENCH:

606.8.2.1 - Trenching:

The FDB trench shall be excavated to the width and depth as detailed on the plans. Trench walls shall be as nearly vertical as practicable

606.8.2.2 - Bedding and Placing Perforated Pipe:

After excavating the trench, Engineering fabric shall be placed in the trench in reasonable conformance with the shape of the trench. The Engineering fabric shall be smooth and free of tension, stress, folds, wrinkles, or creases. The Engineering fabric shall be installed so that any splice joints have a minimum overlap of at least 1 foot (300 mm) any direction. Enough Engineering fabric will be placed in order to properly tie to the mainline placement of Engineering fabric (Item 207034 -*).

A 2 inch (50 mm) bedding layer of crushed stone or gravel conforming to Section 311.2 aggregate shall be placed in the bottom of the trench for its full width and length.

The pipe shall then be placed in the trench. The pipe sections shall be joined with couplings or bands as recommended by the manufacturer.

After pipe installation, the remainder of the trench will be backfilled with crushed stone or gravel conforming to Section 311.2 aggregate.

606.8.3 - OUTLET PIPE:

606.8.3.1 - Connection to Perforated Pipe: At locations designated on the plans or as directed by the Engineer, rigid outlet pipe will be connected to the perforated pipe. A drop connection utilizing a tee or wye or other means as satisfactory to the Engineer will be used for this connection. This operation may be performed concurrently with the placement of the perforated pipe or separately.

606.8.3.2 - Trenching: The outlet pipe trench shall be excavated to the depth of the flow line of the outlet pipe. Minimum slope of the outlet pipe is to be 3%. Width of the trench will be that width which will allow proper room for pipe placement and backfilling operations.

606.8.3.3 - Placing and Backfilling Pipe: The outlet pipe shall be placed in the trench with all ends firmly joined by couplings or bands as recommended by the manufacturer.

The outlet pipe shall be backfilled with random material in accordance with Subsection 606.3.4

606.8.3.4 - Pipe End Treatment: The outlet end of all outlet pipes not tied to drainage structures shall be equipped with a slopewall.

Outlet pipes shall be tied to inlets or culverts by the use of pipe saddles, grouting Cementing, or other means satisfactory to the Engineer.

606.8.4 - METHOD OF MEASUREMENT:**606.8.4.1 - FDB Trench:**

The quantity of work done will be measured by the LF (m) of FDB

606.8.4.2

trench installed, complete in place and accepted. The perforated pipe is a component of the FDB trench. Length will be determined from actual measurements once the FDB trench is in place. No deductions will be made for placement of the drop connection required at outlet pipe locations.

606.8.4.2 - Outlet Pipe:

The quantity of work done will be measured by the LF (m) of rigid pipe complete in place and accepted. Angles, tees, wyes, and other branches which may be required will be included in the length of the outlet pipe. Measurement shall begin at the intersection of the perforated pipe and the rigid pipe.

Slopedwalls for outlet pipe and the connection of outlet pipes to drainage structures will not be paid for separately, but shall be included in the cost of the outlet pipe.

606.9-METHOD OF MEASUREMENT:

The quantity of work done will be measured by the linear foot (meter) for pipe, including outlet pipe, for each of the types and sizes as specified, complete in place and accepted. Length will be determined from actual measurements after the pipe is in place. Angles, tees, and wyes, and other branches which may be required will be measured from centerline of main pipe along the centerline of the branch to the end and the length included in the pipe length.

Crushed stone, gravel, or silica sand for bedding, filter, and spring control will be measured by the volume; the volume will be the product of the specified trench width and depth, and the length in place, less the volume of the pipe computed on the basis of the outside diameter of the barrel or corrugations.

Blind drains will be measured by the volume of granular material.

The quantity of work done for "Aggregate Filled Fabric Underdrains" will be measured in linear feet (meters) of trench, complete in place and accepted.

The quantity of work done for "Prefabricated Edge Drain" will be measured in linear feet (meters) of edge drain and outlet pipe, complete in place and accepted.

Volume will be computed on the basis of the specified trench depth and width, and the length in place.

Underdrain junction boxes will be measured by the unit.

Slopedwalls for underdrains will not be paid for separately, but shall be included in the cost of the underdrain pipe.

606.10-BASIS OF PAYMENT:

The quantities, determined as provided above, will be paid for as provided below, which prices and payments shall be full compensation for furnishing the materials, excavation, placing pipe, filter material, edge drain, outlet pipe, backfill, disposing all surplus material and doing all the work, including all labor, tools, equipment, supplies and incidentals necessary to complete the work.

Payment for engineering fabric for Free Drain Base Trench will be as Item 207034-.*.

606.11-PAY ITEMS:

ITEM	DESCRIPTION	UNIT
606001-*	METALLIC COATED CORRUGATED STEEL PIPE FOR UNDERDRAINS	LINEAR FOOT (METER)
606002-*	BITUMINOUS COATED CORRUGATED STEEL PIPE FOR UNDERDRAINS	LINEAR FOOT (METER)
606003-*	CORRUGATED ALUMINUM ALLOY PIPE FOR UNDERDRAINS	LINEAR FOOT (METER)
606004-*	BITUMINOUS COATED CORRUGATED ALUMINUM ALLOY PIPE FOR UNDERDRAINS	LINEAR FOOT (METER)
606005-*	NON-REINFORCED PERFORATED CONCRETE UNDERDRAINAGE PIPE	LINEAR FOOT (METER)
606007-*	POROUS CONCRETE PIPE	LINEAR FOOT (METER)
606008-*	STANDARD QUALITY CONCRETE DRAIN TILE	LINEAR FOOT (METER)
606009-*	EXTRA QUALITY CONCRETE DRAIN TILE	LINEAR FOOT (METER)
606010-*	SPECIAL QUALITY CONCRETE DRAIN TILE	LINEAR FOOT (METER)
606011-*	STANDARD CLAY DRAIN TILE	LINEAR FOOT (METER)
606012-*	EXTRA QUALITY CLAY DRAIN TILE	LINEAR FOOT (METER)
606013-*	HEAVY DUTY CLAY DRAIN TILE	LINEAR FOOT (METER)
606014-*	STANDARD STRENGTH PERFORATED CLAY PIPE	LINEAR FOOT (METER)
606015-*	EXTRA STRENGTH PERFORATED CLAY PIPE	LINEAR FOOT (METER)
606016-*	CRADLE INVERT CLAY PIPE	LINEAR FOOT (METER)
606017-*	FIBER CEMENT PIPE FOR UNDERDRAINS	LINEAR FOOT (METER)
606018-*	PREFABRICATED EDGE DRAIN**	LINEAR FOOT (METER)
606019-*	BITUMINIZED FIBER PIPE FOR UNDERDRAINS	LINEAR FOOT (METER)
606020-*	AGGREGATE FILLED FABRIC UNDERDRAINS*	LINEAR FOOT (METER)
606021-*	BLIND DRAIN	YARD (METER)
606022-*	CRUSHED STONE, GRAVEL, OR SILICA SAND FOR UNDERDRAINS	YARD (METER)
606023-*	UNDERDRAIN JUNCTION BOX	EACH
606024-*	CORRUGATED STAINLESS STEEL PIPE FOR UNDERDRAINS	LINEAR FOOT (METER)
606025-*	UNDERDRAIN PIPE	LINEAR FOOT (METER)
606026-*	PRECOATED, GALVANIZED STEEL PIPE FOR UNDERDRAINS	LINEAR FOOT (METER)
606027-*	CORRUGATED POLYETHYLENE UNDERDRAINAGE PIPE	LINEAR FOOT (METER)
606028-*	PERFORATED PLASTIC SEMICIRCULAR PIPE	LINEAR FOOT (METER)

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606029-*	FREE DRAINING BASE TRENCH	LINEAR FOOT (METER)
606030-*	OUTLET PIPE, "size"	LINEAR FOOT (METER)

* Sequence Number

SECTION 607 GUARDRAIL

607.1-DESCRIPTION:

This work shall consist of the construction or reconstruction of guardrail in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Plans or established by the Engineer.

The types of guardrail are designated as follows:

Type 1, Galvanized Steel Deep Beam Type Guardrail

Type 2, Blank

Type 3, Blank

Type 4, Blank

Type 5, Galvanized Steel Double-Faced Guardrail (Deep Beam Type)

All installations of Type 1 & 5 Guardrail will be classified according to one of the designations specified. The guardrail class will be indicated in the pay items and on the Plans,

Class I: 6 ft. - 3 in. (1 905 mm) post spacing with blocks

Class II: 12 ft. - 6 in. (3 810 mm) post spacing with blocks

Class III: 12 ft. - 6 in. (3 810 mm) post spacing without blocks.

The construction of the guardrail shall include the complete furnishing, assembling and erecting of all component parts and materials at the location shown on the Plans or directed by the Engineer.

A Modified Cut Slope Terminal shall consist of supplying and installing additional length guardrail posts, an additional W-beam guardrail section (bottom beam), and standard guardrail cut slope terminal components

607.2-MATERIALS:

Materials shall meet the requirements of the following Subsections of Division 700: